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STATISTICAL STUDIES ON FIRE INCIDENTS INVOLVING TEXTILES

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ON

FIRE INCIDENTS INVOLVING TEXTILES

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1. Introduction

I am very happy to be here today and proud to have been invited to give this presentation. It is both a pleasure and an honor to be on the program of this Conference.

Because it is a special honor to be invited to speak before you, I have given much thought to this presentation. I was told that the audience will be composed of high-level representatives of the fiber, textile, and garment industries with a sprinkling of high government officials and executives. Such an audience, it seemed to me, would not be interested in mere numbers - in learning how many incidents of a certain type we have in the USA. But yet, the subject of my presentation deals with textile fire statistics, and it obviously must deal with numbers. What I have decided to do, therefore, is to emphasize the methodological aspects of my topic rather than the findings. Accordingly, I will start with a description of the Flammable Fabrics Accident Case and Testing System. FFACTS, as we call the system, has been the major single source of data on fabric fire incidents during the past five years, and it is important that you know something about its strengths and limitations. I will then review for you the

analytical methodology used in the development of priorities for flammability standards. Next I will discuss the two major statistical systems dealing with data on textile fires in the USA. And finally, I will bring you up to date on recent developments on the international level.

2. The Flammable Fabric Accident Case and Testing System.

The Flammable Fabrics Act [1] authorized the promulgation of flammability standards for fabric products to protect the public against unreasonable risk of fire leading to death, injury, or significant property damage. In 1973 the responsibility for this Act was assigned to the Consumer Product Safety Commission [2] . The National Bureau of Standards provides technical support to the Commission, and up to 1975 the Flammable Fabrics Accident Case and Testing System was included in this support. At that time it was transferred to the Commission.

As initially conceived, FFACTS was to provide statistical data on deaths, injuries, and economic losses resulting from "unreasonable risks", as required by law, and to aid in establishment of priorities for standards [3] . It was also planned that it would develop information on the behavior of fabric products in fire incidents, to help in designing small-scale tests that could predict real-life behavior; and that it would contribute to the common store of knowledge on the nature of fabric flammability. As it turned out, it was also instrumental in developing information on the role played by ignition sources in flammable fabric incidents, and it aided in developing suggestions on how they can be designed for improved safety.

Input for FFACTS are in-depth investigative reports on flammable fabric incidents. Using specially designed forms, investigators around the country follow and report on accidental fires involving textile products. These reports are screened to be sure that they are in fact relevant and that they contain enough information to make processing worthwhile. If found acceptable, the reports are carefully analyzed and the information derived from them, together with data from laboratory tests performed on any remains of the involved fabric products received, are encoded and computerized.

Because the investigations do not follow a statistically designed sampling plan, the FFACTS data base is not a statistically representative sample of all fabric fires in the United States. However, many trends which began to develop in the early data have remained consistent while the geographical sources and the collection methods have changed several times, and the data base doubled and tripled in size. It thus appears that FFACTS data reflect the actual fire experience in the United States.

3. Selection of Priorities for Standards.

By the time the FFACTS data base contained two thousand incident reports, the methodology applied to analyze the data had been developed into a formal protocol [4] . The process of developing priorities for flammable fabrics standards called for successive examination of the data in the light of nine criteria, with each step producing a more refined stratification and eventual identification and ranking of the most severe hazards.

TABLE 1. [4]

CRITERIA APPLIED IN DEVELOPING PRIORITIES FOR FLAMMABLE FABRIC STANDARDS

* Definition of population
* Flammable liquid involvement
* Distribution by item category
* Distribution by sex
* First-to-ignite
* Severity of injury
* Age group
* Technological practicability
* Regulatory feasibility

The first step called for defining the population to be studied. In the example I will be using, that population consisted of the 1,492 garment-involving incidents contained

in the December 1972 FFACTS data base of 1,964 incidents reports.

The second decision concerned incidents in which contamination with a flammable liquid, such as gasoline, may have obscured the role played by the garment. Because such incidents do not help in the identification of intrinsically hazardous garments, they were eliminated from further consideration.

The remaining incidents were then distributed by garment category. Sleepwear ranked first in frequency, with underwear, shirts, pants, and dresses following in that order.

TABLE 2. [4]

Most Frequently Involved Garment Categories
(FFACTS, December 1972)

Garment	Number of Incidents
Sleepwear	391
Underwear	349
Shirts/Blouses	255
Pants	152
Dresses	120

Distributing the data by sex and frequency put women's sleepwear in the first place and dropped men's sleepwear to the bottom of the list. Underwear was still high on the list, with men's underwear in the second, and women's in the fourth place.

TABLE 3. [4]

Most Frequently Involved Garment Categories by Sex (FFACTS, December 1972)

Garment	Sex	Total Incidents
Sleepwear	Female	298
Underwear	Male	212
Shirts	Male	200
Underwear	Female	137
Pants	Male	129
Dresses	Female	119
Sleepwear	Male	93

The application of the next criterion in the selection process resulted in the elimination of all garments which were not first-to-ignite from further consideration. This criterion was applied on the assumption that the first garment ignited largely determines the hazard. It should be pointed out, however, that while this assumption may be reasonable, it has not been proven. Moreover, because the order of ignition is often not determinable in the more severe cases, particularly

if the victim does not live to tell the story, the application of this criterion tends to introduce a bias.

The elimination of all garments which were not first-to-ignite produced a major change in ranking. Underwear, which was often involved but rarely as the first ignited item, dropped to the bottom of the list.

TABLE 4. [4]

Most Frequently Involved First-to-Ignite Garment Categories by Garment type/Sex group (FFACTS, December 1972)

Garment	Sex	Total Incidents	Number First to Ignite
Sleepwear	Female	298	243
Shirts	Male	200	120
Dresses	Female	119	78
Sleepwear	Male	93	75
Pants	Male	129	42
Underwear	Male	212	23
Underwear	Female	137	4

The next criterion in the selection process deals with injury severity. However, while this criterion was considered in 1972, it was not actually applied, because we did not know how. It is now 1975, and though much work has been done on this problem, the relationship between injury severity and fabric or garment parameters is still not fully elucidated.

A study on the February 1974 FFACTS data base of 3,047 incident reports, showed that the cover and fit of a garment correlate with extent of burn injury significantly, with shirts

and pants showing least extensive burn injuries, pajamas intermediate, and dresses, nightgowns, and robes showing most extensive burns [5]. Of the other fabric/garment parameters studied, only fiber content showed a significant correlation, with garments made from all-cellulosic and cellulosic-blend fabrics showing a correlation with more extensive burns than those made from single-layer fabrics made from thermoplastic fiber. Multi-layered garments from thermoplastic fiber fabrics tended to behave more like the cellulosics than like single-layer thermoplastics. Fabric weight, construction, surface characteristics, and burn time showed no consistent correlation with extent of injury. It must be remembered, however, that many of the large-cover garments, such as robes and dresses, tend to be worn by older people and by females, and their defensive capabilities are in general not as good as those of younger people and males. For this reason the question of the intrinsic hazard of such garments is still not fully answered. Accordingly, we are still unable to apply an injury severity criterion to the priority development process.

Age of the victim was the next criterion applied, and to make the data more meaningful the age continuum was divided into age groups believed to exhibit broadly similar behavior patterns. Of course, the fractions of the total population in each of these sex-age groups are not equal and the data

had to be rationalized to permit rank ordering. This was done by dividing the number of garments in a given sex-age group by the proportion of the U.S. population represented by that sex-age group. Thus, for example, the first-to-ignite sleepwear/female incidents were distributed by age group. This showed that there were 50 incidents in the 0-5 age group. This number was divided by .051, since girls in the 0-5 age group constitute 5.1% of the total US population. The resulting number, 98, is the highest on the list and indicates the highest hazard level.

The values obtained in this manner are called relative incident frequency indexes because they show the relative frequency of involvement of various garment types for different portions of the population. They can be compared across age groups and garment types, and thus make possible the achievement of the objective of the entire process, the rank-ordering of candidates for garment flammability standards in accordance with the hazard they represent.

In the example we have been following, this ranking put sleepwear in the first four places - sleepwear for females in the 0-5 group first, with an index of 98, sleepwear for females in the 6-12 age group second, with an index of 87, sleepwear for females 66 years old and older third, and sleepwear for males in the 0-5 age group fourth. The next highest category, dresses for girls in the 0-5 age group have an index of 49, one half that of the first-ranking item.

TABLE 5. [4]

RELATIVE INCIDENT FREQUENCY INDEX VALUES
FOR GARMENT TYPE-SEX-AGE GROUPS

Garment	Sex	Age Group	Index Value
Sleepwear	Female	0-5	98
Sleepwear	Female	6-12	87
Sleepwear	Female	66+	71
Sleepwear	Male	0-5	69
Dresses	Female	0-5	49
Sleepwear	Female	46-65	40
Shirts	Male	66+	35
Dresses	Female	0-12,66+	29(ea)
Shirts	Male	13-20	26
Sleepwear	Female	21-45	24
Shirts	Male	21-45	24
Shirts	Male	46-65	23
Sleepwear	Male	66+	23
Sleepwear	Male	6-12	22
Shirts	Male	0-5	21
Shirts	Male	6-12	18
Sleepwear	Female	13-20	14
Pants	Male	0-5,66+	13(ea)
Pants	Male	46-65	11
Dresses	Female	46-65	9
Pants	Male	6-12	8
Pants	Male	21-45	7
Sleepwear	Male	46-65	7
Sleepwear	Male	13-20	5
Pants	Male	13-20	4
Dresses	Female	21-45	4
Sleepwear	Male	21-45	43
Dresses	Female	13-20	1

The groups ranked high by the relative incident frequency index values represent the highest hazards and constitute priorities for flammability standards. However, standards must be technologically practicable, and the ability of the industry to provide the necessary flame resistant garments must be given due consideration. Of course, three out of the

first four highest ranking groups identified in this analysis are already covered by standards. The fourth one, sleepwear for females 66 years and older, presents a regulatory feasibility problem, since sleepwear for the elderly cannot be distinguished from other adult sleepwear, and there seems to be no way for a mandatory regulation to include that segment of the population, and exclude the remainder which need not be made subject to the regulation.

It would be possible to apply a regulation across the board, as for example to all sleepwear for females. However, the desirability of such action has been questioned, even if it were considered technologically practicable. According to preliminary study by the Bureau of Economic Analysis of the Consumer Product Safety Commission, treating the fabric yardages used in nightwear, shirts, and trousers so that they can meet a vertical self-extinguishing test similar to FF5-74 [6] would increase the retail value of the apparel by from 2.5 to 5 billion dollars [7]. The direct cost of treating sufficient yardage to replace the garments that would fail such a test were estimated to be $310 million for women's nightgowns, $81 million for robes and housecoats, $72 million for men's pajamas, $340 million for dresses, $786 million for men's and boys' shirts, and $516 million for men's and boys' trousers. These numbers underscore the need for an accurate determination of the magnitude of textile

flammability hazards in terms which permit comparison with other hazards and with costs of remedial actions. This FFACTS cannot do, because the priorities that can be derived from an analysis of FFACTS data are relative priorities, and they constitute a ranking within the fabric products family.

4. Statistical Systems.

For this reason, much current effort in the United States is aimed at supplementing the detailed studies of flammable fabric incidents, such as those in FFACTS, with systems capable of providing statistically valid data and placing the entire textile fire problem on a more quantitative basis. Of these there are two major ones, the National Electronics Injury Surveillance System (NEISS) [8], and the National Fire Data System (NFDS) [9].

NEISS is run by the Consumer Product Safety Commission. In essence, it is an injury monitoring system designed to determine the nature and scope of consumer safety problems. It is set up as a network of 119 statistically selected hospital emergency rooms. The data collection begins when the patient shows up in the emergency room for treatment. The admission clerk obtains basic information about the accident, and records it. This information is then coded and transmitted electronically to the CPSC in Washington, where it is collected and organized.

NEISS data are published monthly in NEISS News. According to the July 1975 issue, 34 clothing-involving accidents were reported in April to the emergency rooms of the 119 NEISS hospitals [10]. Just to give a flavor for the variety of products listed, I will mention that this compares with 2,239 accidents involving stairs, 1,458 involving bicycles,

95 involving cooking ranges, and 5 involving water heaters. Generally, accidents involving fabric products do not rank high on the NEISS list.

TABLE 6. *

Injuries Treated at NEISS Hospitals - Association with Selected Consumer Products

Product Description	Number of cases		By Sex %	
	April	7/14/74 4/30/75	M	F
Stairs & Landings	2,239	18,791	42	58
Bicycles	1,458	13,825	65	35
Cooking ranges, ovens	95	987	45	55
Clothing, day and night	34	227	41	59
Water heaters	5	93	40	60

*Values for products selected for illustrative purposes from the July 1975 issue of NEISS News (Vol. 4, No. 1)

NEISS is well suited to perform the product injury surveillance function it is meant to perform, but it is not ideal from the point of view of the textile fire problem. It covers only those incidents that result in an injury that is treated in a hospital emergency room. This means that those who die, those who go directly to burn centers, those who go to private physicians,and those who don't seek medical help at all are not visible to the system. Moreover, because the system was designed to relate only one product to each incident, the data may be difficult to interpret in terms of

fire incidents, which must be characterized by two products, an ignition source and the material ignited.

NEISS is a useful tool, and efforts are now being made to make it even more useful in the fire area. The CPSC is running surveys to determine the number of injuries that are not treated in hospital emergency rooms, and this will permit them to develop correction factors for their estimates. They have also started to flag fire-involving accidents with a special code, to permit easy identification.

The National Fire Data System is a vital part of the new National Fire Prevention and Control Administration's Fire Data Center [11] . When the Congress established the Administration, in 1974, it set for it several major objectives. Among them are to:

* Provide an accurate nationwide analysis of the fire problem
* Assist in setting priorities
* Identify major problem areas
* Determine possible solutions
* Monitor fire losses

The NFDS was established to address these objectives. To do that, it must quantify the fire problem and its components, to determine their magnitude. Necessarily, this requires the determination of the magnitude of the textile fire problem.

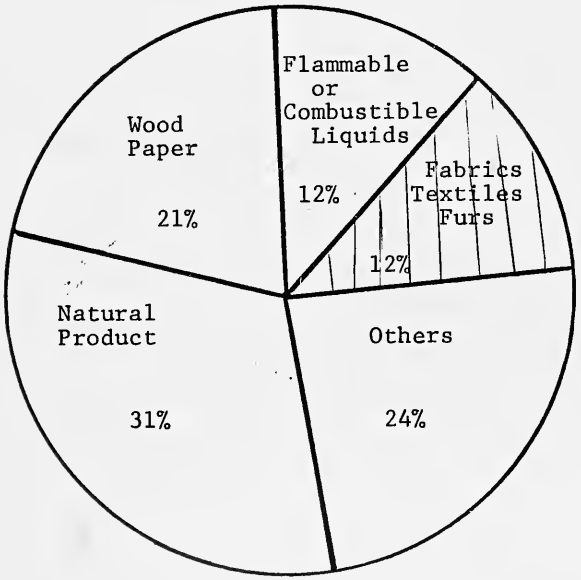
A major subsystem of the NFDS collects fire incident reports prepared by the fire service. This subsystem was

tested last year in a pilot-phase operation, and in the process collected some data. The statistical significance of that data is not determinable, because of the pilot-phase nature of the operation, and not much credence should be given to the actual numbers reported. However, I will cite them here as example of the kind of data that will come from the system in the future.

The fire incident reports collected during the pilot phase effort included questions about causal factors. Among them was a question concerning type of material first ignited, and 46,837 reports carried an answer to that question: textiles or fabrics were the first materials ignited in 5,552 cases, or in about 12% of the total. Fabrics and textiles constituted the fourth largest class of the nine major classes of "type of material first ignited", ranking only behind flammable or combustible liquids, natural products, and wood and paper. Within the fabrics and textiles class, cotton and rayon textiles accounted for 63% of the total; synthetic fibers or fabrics were second with 25%. Expressing the same values in another way, cotton and rayon products were first materials to ignite in 7% of all fires, and synthetics in 3%.

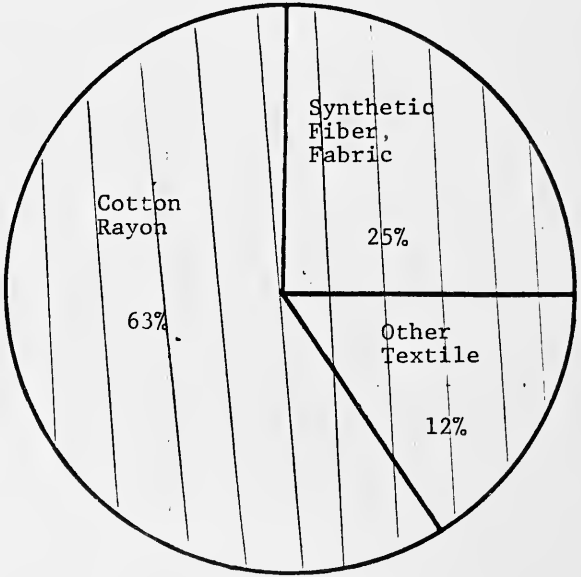
Another question asked in the pilot-phase fire incident report concerned the form of material first ignited. From a data base of 46,686 incidents for which this question was answered, soft goods and apparel accounted for 3,279 cases, or 7% of the total.

FIGURE 1



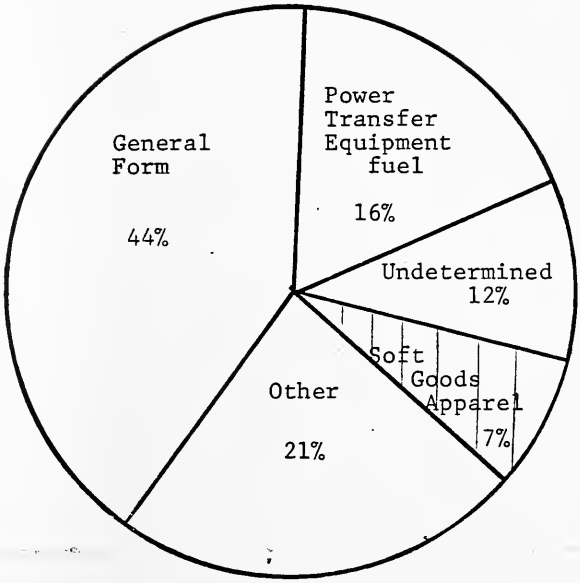
Classes of type of material
first ignited
NFIRS - Pilot Phase
46,837 incidents

FIGURE 2



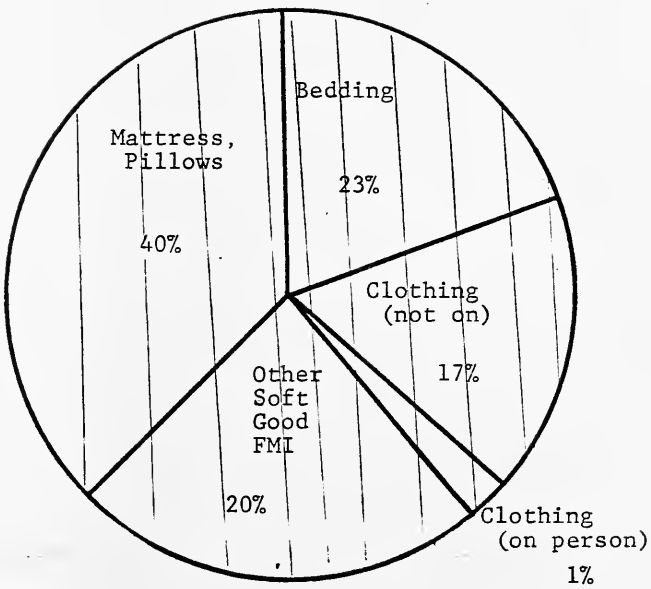
Categories of type of material
first ignited in the fabrics,
textiles, furs class
NFIRS - Pilot Phase
5,552 incidents

FIGURE 3



Classes of form of material
first ignited
NFIRS - Pilot Phase
46,686 incidents

FIGURE 4



Categories of form of material first ignited in the soft goods, apparel class
NFIRS - Pilot Phase
3,279 incidents

The class of soft goods and apparel includes nine categories: mattresses and pillows; bedding; linen; clothing (not on the person); clothing (on the person); curtains and drapes; soft goods - not made up; luggage; and other or undetermined soft goods. The category most frequently noted was mattresses and pillows. They comprised 40% of the 3,279 incidents in the class. The second highest category was bedding, which contained 23% of the total for the class. These two categories account for 5% of all the forms of materials ignited, a number pointing out the hazard of smoking in bed. The clothing (not on person) category comprised 17% of the soft goods class, but the clothing (on the person) category only 1%.

The relatively small number of clothing (on the person) ignitions points out a shortcoming of the fire incident subsystem as seen from the textile point of view. Because it is limited to fires attended by the fire service, it misses all the garment fires that are put out by the victim or his family or friends. How many of these fires are garment fires is open to question, but the over-all percentages derived from the pilot-phase operation do not differ markedly from the percentages produced by another tool of the NFDS, National Household Fire Survey [12].

The National Household Fire Survey was conducted in April 1974 to obtain an overview of the national household fire

problem. Thirty-three thousand households - a statistically selected sample of U.S. households - were interviewed and asked whether they experienced a fire during the previous 12 months. If the answer was yes, they were asked a number of questions concerning the fire.

The statistical projection for the yearly total of household fires based on answers to these questions is 5,575,000. Of these, interior furnishings (carpets, rugs, curtains, upholstered furniture) were indicated as first-to-ignite items in an estimated 285,000 incidents, clothing in 159,000, bedding in 115,000, and other fabric items in 69,000 incidents. These add up to a total of 628,000, and that means that according to the survey textile products constitute about 11% of all the first-to-ignite items.

TABLE 7*

TOTAL NUMBER OF HOUSEHOLD FIRES	5,575,000	100%
ALL TEXTILE FIRES	628,000	11%
Interior Furnishings	285,000	5%
Clothing	159,000	3%
Bedding	115,000	2%
Other Fabrics	69,000	1%

*National Household Fire Survey

In terms of dollars, the total loss from fires in which textile products were first to ignite constituted an even larger percentage of the projected national total of about $1.5 billion. The loss for clothing was a projected $77 million, for walls and floor coverings - $283 million, and for furnishings - $84 million. This adds to a total of $445 million worth of damage from fires where a textile product was first to ignite, and it constitutes about 28% of the projected national total.

TABLE 8*

DOLLAR LOSS FROM ALL HOUSEHOLD FIRES (in millions)	$1,545	100%
DOLLAR LOSS FROM TEXTILE FIRES	$ 445	28%
Walls & Floor Coverings	$ 283	18%
Clothing	$ 77	5%
Interior Furnishings	$ 84	5%

*National Household Fire Survey

Four hundred and forty-five million dollars is a large sum, and there is no doubt that fires involving textiles will continue to receive attention. However, the numbers I have been citing are "soft", and it is difficult to make rational, cost-benefit decisions on such data. The task before us now is to firm these numbers up, so as to quantify the textile fire hazards and place them in the context of other consumer safety hazards and in the context of the total fire problem.

5. International-level Activities.

Fire is an international problem, but at the present time it is extremely difficult to compare fire losses in one country with fire losses in another. The statistics, if collected at all, are collected on different bases, with each country including or excluding different types of fire, using its own definitions, and classifying the data in different ways. Reliable statistics on textile fires, in particular, are very scarce. However, efforts to develop a basic international system for textile fire data, capable of producing statistics that could be compared from country to country, are underway under the auspices of the International Organization for Standardization. The Subcommittee on Burning Behaviour of Textiles and Textile Products of the Committee on Textiles is the body responsible for the effort, but the actual work is performed by the Subcommittee's Working Group 6, on Risk Data Analysis (ISO/TC38/SC19/WG 6). The Working Group held three meetings over the past couple of years - in Zurich in June 1974, and in Paris in October 1974 and May of this year. The meetings were attended by experts from Australia, Belgium, Canada, France, Germany, Italy, Japan, Netherlands, Norway, Switzerland, United Kingdom, and the United States of America. The meetings of our parent Subcommittee were also attended by representatives of Austria, Denmark, Finland, South Africa, Spain,and Sweden, so that these countries also had an opportunity to participate in the effort.

We have exchanged information about the status of textile data systems in the various countries, and I might mention that they range from rudimentary ones all the way to sophisticated systems, such as that in France, which is capable of producing complex reports and answering queries.

Having become acquainted with each other and with fire data systems in each other's countries, the Working Group agreed that because it would be impractical to collect detailed data on all fire incidents it is necessary that a bi-level system be established. This system would do two things:

(1) Collect statistical data on fires to determine the scope and magnitude of textile fires and flag textile fires for task 2;

(2) Collect detailed data from an appropriate sample of textile fires.

The Working Group also agreed that maximum use should be made of existing systems and other existing resources.

To achieve these objectives, the Working Group agreed that its members will: (1) Send information on statistical data on fires, including textile fires, to the United States - to my office - for a preliminary examination and perhaps the development of a tentative list of data elements to be used in a standard international fire incident reporting form; and (2) send detailed reports on textile fires to the expert from United Kingdom, Dr. Janet Thompson, for the same

purpose. Following the Working Group's meetings, the Subcommittee in a plenary session reviewed these plans and formally endorsed the effort to examine data from a number of different countries, evaluate it, and try to propose standardized international forms for reporting fire incidents.

The date and place of the next meeting of WG 6 has not yet been set, though I can tell you that the U.S. delegation agreed to issue an official invitation to the Subcommittee to meet in the USA in September 1977. This is two years from now, but the tasks undertaken by the Subcommittee and its Risk Data Analysis Working Group are very substantial, and we are already behind schedule. Still, progress is being made. We have been able to define what we want to do, and agreed on how to do it. This, I am told, is half the battle. I am optimistic that it will not be very long before standard national and international textile fire statistics become available and permit us to learn what is the magnitude of the textile fire problem, and what are the high-priority targets for standards, codes, public education, and research.

References Cited

1. Flammable Fabrics Act, Amended and Revised December 14, 1967. (81 Stat. 568; 15 USC 1, 191)

2. Consumer Products Safety Act, May 14, 1973 (86 Stat., 1221, 15 USC 2064B)

3. Vickers,A.: The Flammable Fabric Accident Case and Testing System (FFACTS). Presented at the Interagency Review of Materials Information and Data Conference, National Bureau of Standards, April 16-17, 1974. In publication.

4. Tovey, H. and Vickers, A.: National Priorities for Flammable Fabrics Standards. Information Council on Fabric Flammability, Proceedings of the Sixth Annual Meeting, December 7, 1972.

5. Vickers, A., Tovey, H., and Krasny, J.F.: Hazard Analysis of Apparel Fires. Presented at the 44th Annual Meeting of the Textile Research Institute, New York, March 27-29, 1974. In publication.

6. Standard for the Flammability of Children's Sleepwear, Sizes 7 through 14 (FF5-74). Federal Register, Vol. 39, No. 85, Wednesday, May 1, 1974.

7. Clones, J.: Potential Economic Impacts from Expansion of FR Requirements to Six Specified Apparel Areas. Bureau of Economic Analysis, Consumer Product Safety Commission, Staff Working Paper, presented at a meeting of the National Advisory Committee for the Flammable Fabrics Act, June 10, 1975.

8. National Electronic Injury Surveillance System. Product Safety Report, July 1975. The Consumer Product Safety Commission, Washington, D.C.

9. Tovey, H.: The National Fire Data System. Bulletin of the American Society for Information Science, Vol. 1, No. 7, 1975.

10. NEISS News for July 1975, Vol. 4, No. 1. The Consumer Product Safety Commission, Washington, D.C.

11. The National Fire Prevention and Control Act of 1974 (P.L. 93-498).

12. Highlights of the National Household Fire Survey. The National Fire Prevention and Control Administration, Washington, D.C. 1975.

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